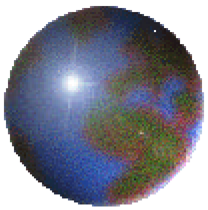


Early Aqua Results from DAO

Joanna Joiner, Don Frank, Emily Liu, Paul Poli

Outline

- Introduction
  - What is in our Aqua data set and why?
  - What is in our assimilation system?
  - How are we currently doing cloud detection?
- Observed minus Forecast (O-F) radiances
- Tuning with collocated radiosondes, analysis above (channels that don't see surface), DAO analysis over ocean downstream of data-rich areas for other channels
- Conclusions

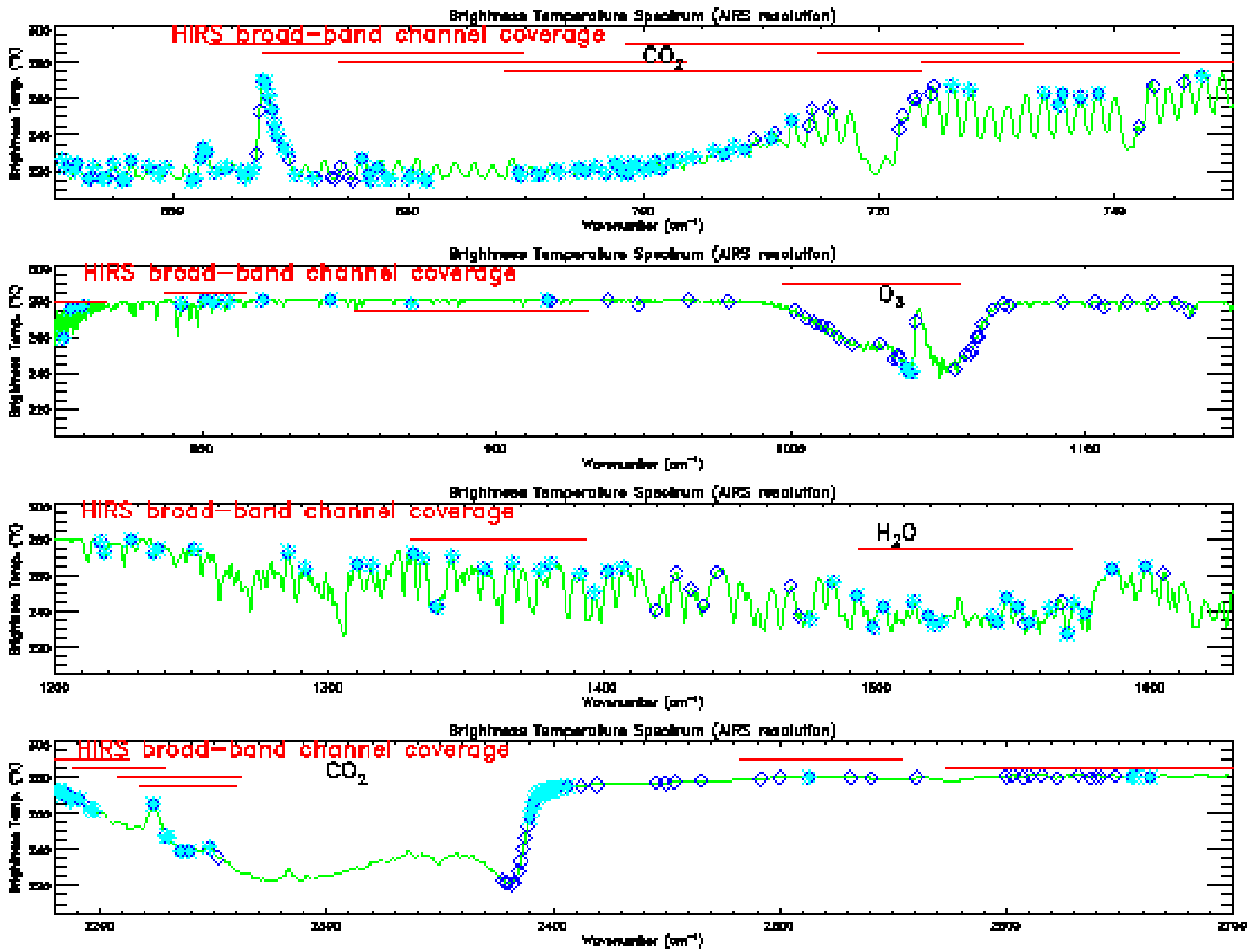
Which data is DAO using?

- All 9 AIRS golfball pixels (other NWP centers are only getting center pixel)
- Every other golfball (may be decreased to 1 in 7), other centers also get every other
- Same 281 channels as NCEP
- DAO validation effort includes evaluation of level 2 data

Why did we request this data set?

- To perform cloud-clearing within our 1D variational assimilation scheme
  - New studies (McNally) show that meteorologically-sensitive areas often occur in cloudy areas. Fourrie showed sensitive areas occur under cloud-tops
  - Hope to show cloud- and land-affected data produces positive impact on NWP
- To improve cloud detection (on a channel by channel basis)
  - Allows for background/microwave-independent check for above-cloud channels (rank channels, then apply homogeity test downwards til reach cloud top)
  - Can average clear pixels for noise reduction
  - Need good estimate of NEDN

AIRS initial channel selection



Forward Radiative Transfer Models

- Our 1DVAR can use different RT codes for different channels (completely flexible)
- We currently support:
  - GLATOVS (Susskind et al): HIRS, MSU, SSU
  - MIT (Rosenkrantz): MSU, AMSU
  - OPTRAN (McMillin, van Delst, Kleespies): HIRS, MSU, AMSU, GOES, AIRS
  - HFFP (Wehr and Strow): HIRS
  - SARTA (Strow, Hannon; fast, approximate analytic Jacobian added by Joiner): AIRS

Cloud detection

- Background window channel check (Derber and Wu) |O-F(HIRS 8, 18, 19)|<1 K sea, <3K land (for AIRS, pick clean window channels at similar frequencies)
- Albedo check from VIS channel (TOVS) and frozen sea test (McMillin and Dean)
- Long-wave/short-wave consistency checks (retrieved surface skin from long-wave and short-wave must agree to within 1K)
- FOV homogeneity check on a channel-by-channel basis (if passes, average all FOVs)
- 1DVAR residual checks (longwave, shortwave, microwave window channels must be fit to within expected errors).
- ~10% found clear, ~1% clear in all 3 FOVs

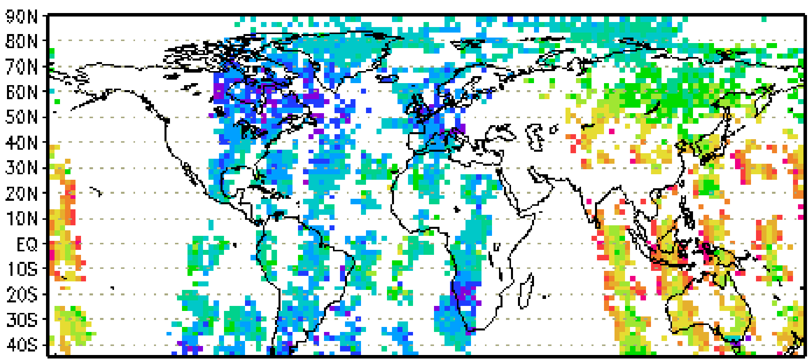
Observed minus forecast radiances

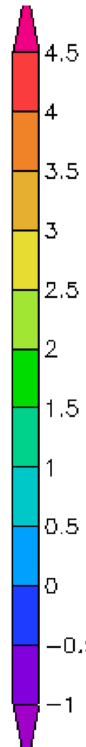
- DAO model top at 0.01 hPa
- Off-line ozone assimilation system (assimilate SBUV) provides 3D ozone that agrees very well with ozone sondes (not used) and TOMS
- Surface skin temperature bias-correction and analysis scheme (uses TOVS and soon surface station data) presents more accurate surface skin temperatures than free-running land surface model
- Also have the ability to compute O-F from hybrid NCEP (troposphere, lower stratopshere, skin temperature), DAO (stratosphere, mesosphere + ozone) fields

DAOTOVS 1DVAR system

- Variational cloud-clearing (Joiner and Rokke, 2000); eigen-vector FOV (AIRS ATBD);
- Use land, solar-affected data, CERES emissivity data set; FASTEM, Masuda over ocean
- Can turn cloud-clearing/land-affected on/off; relaxes to approaches similar to “clear-channel”
- Physically-based systematic error correction (tuning), use optical depth sensitivty as predictor
- Runs in GEOS-DAS and Finite-volume DAS (FVDAS), “first look” ~1 day and “late-look”- weeks after data time

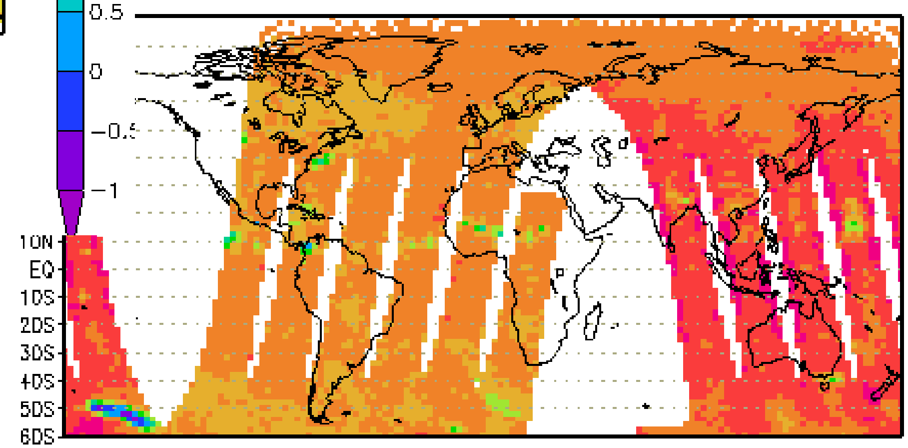
Channel 236 (2104) 2382.7 cm^{-1}

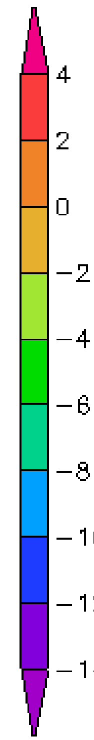




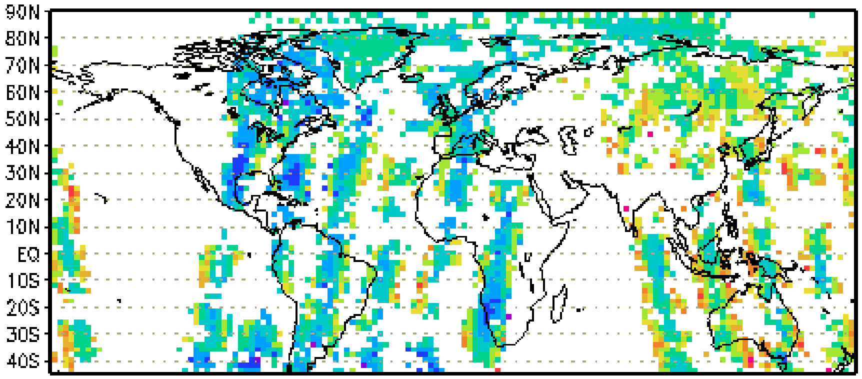
Clouds detected and removed

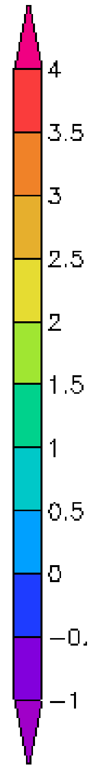
Cloud-contaminated





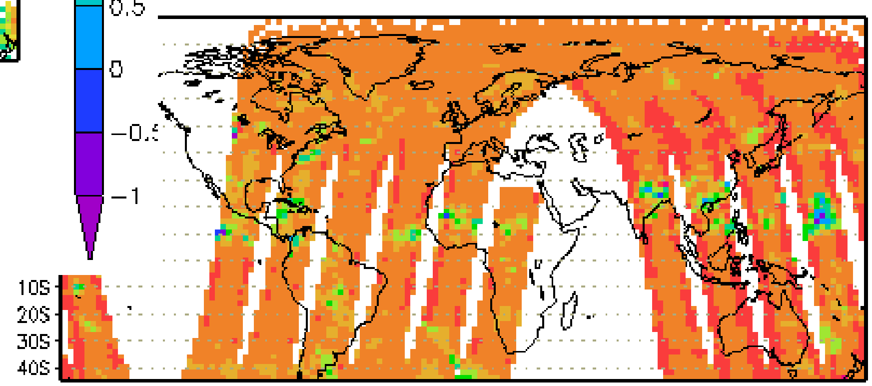
Channel 237 (2106) 2384.7 cm^{-1}

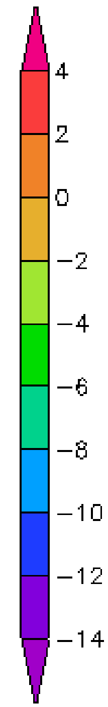




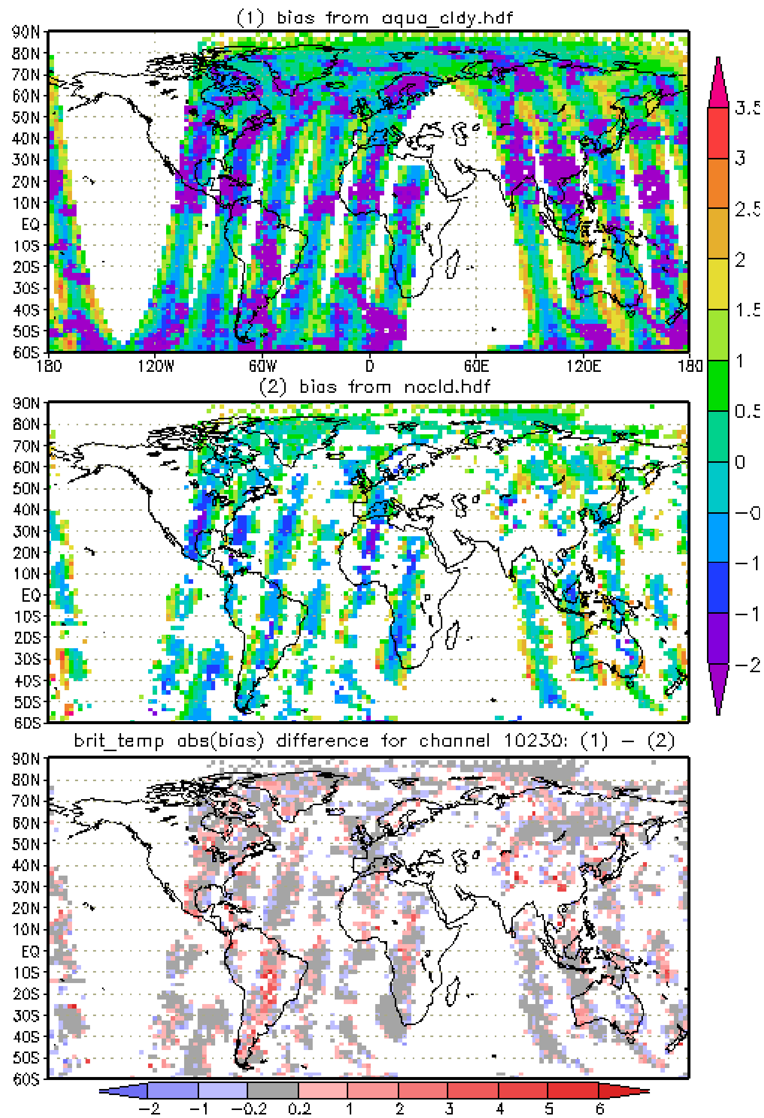
Clouds detected and removed

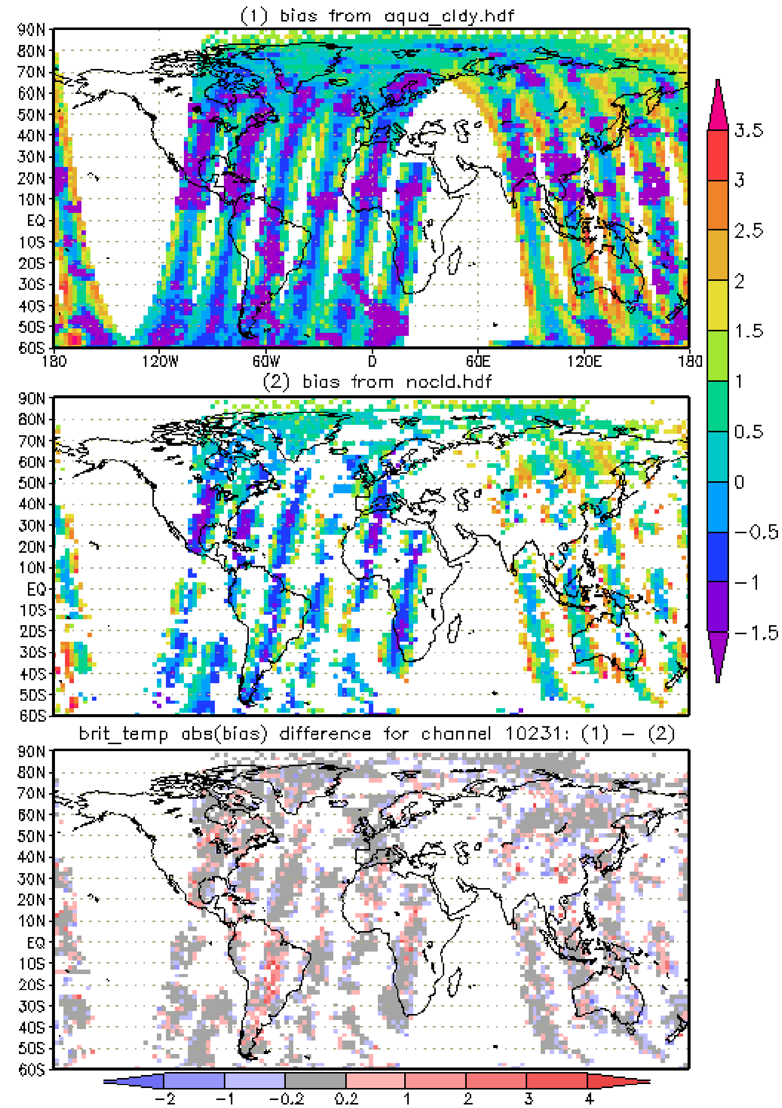
Cloud-contaminated



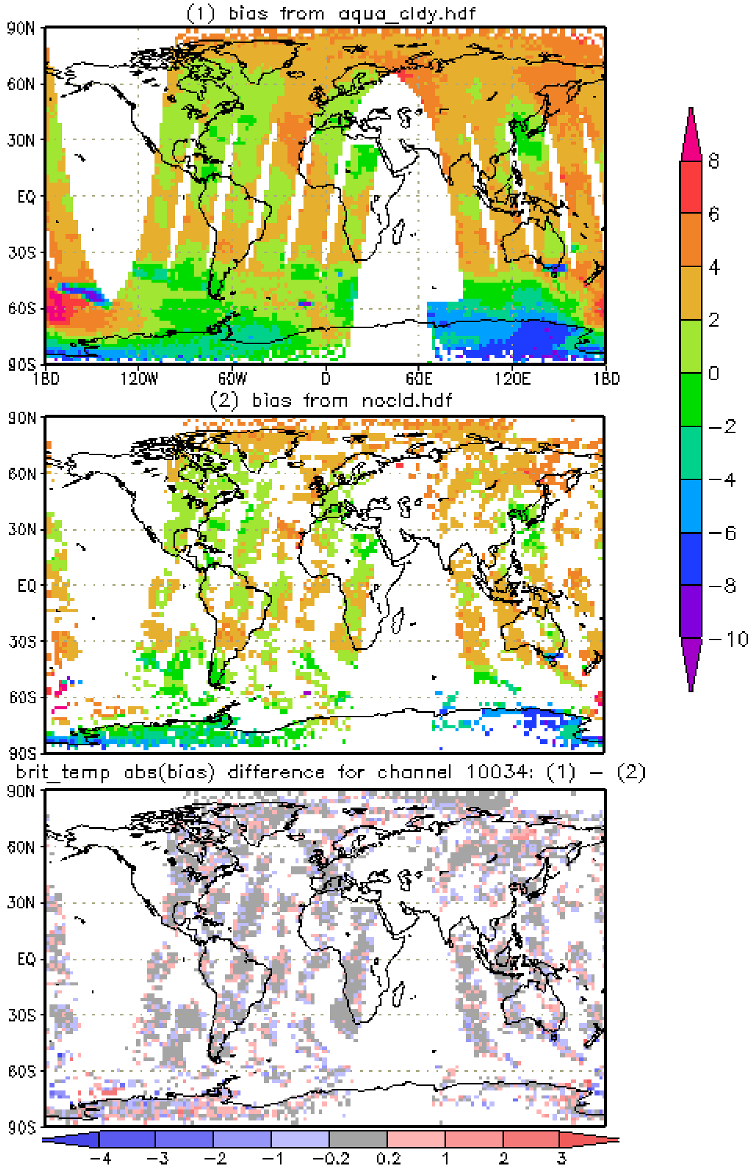


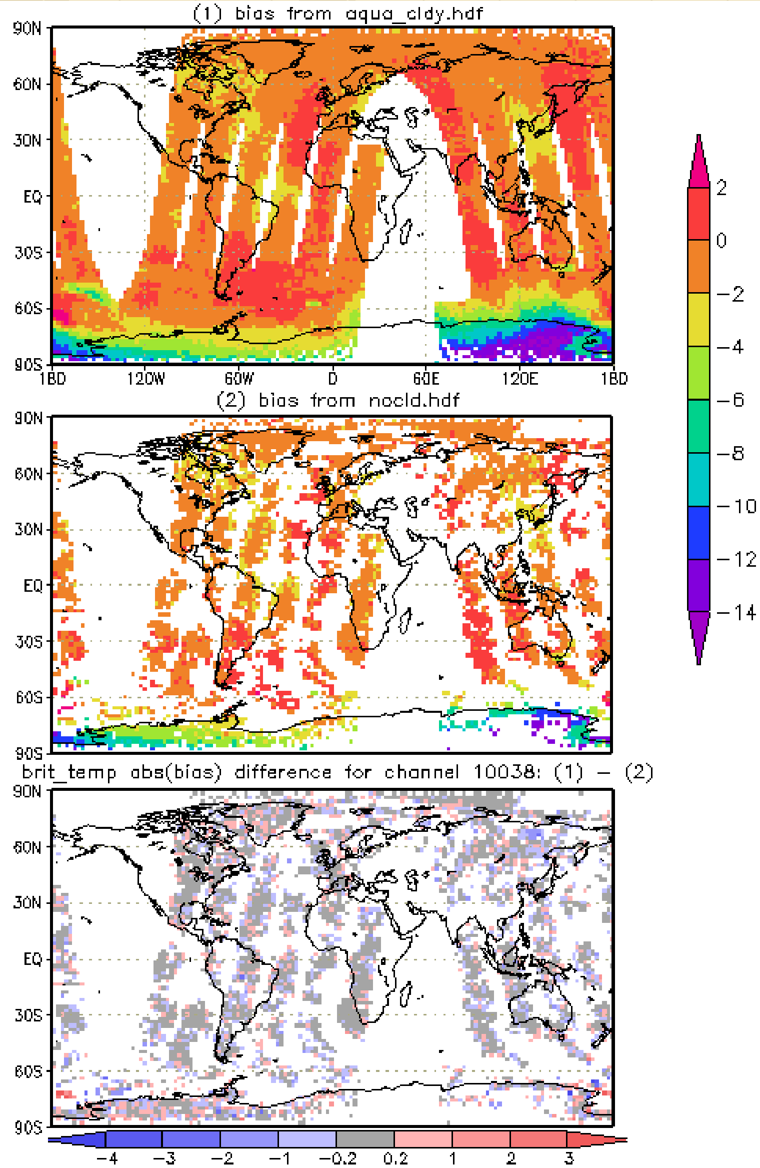
Channels 230, 231 (2248.1, 2251.95 cm $^{-1}$)



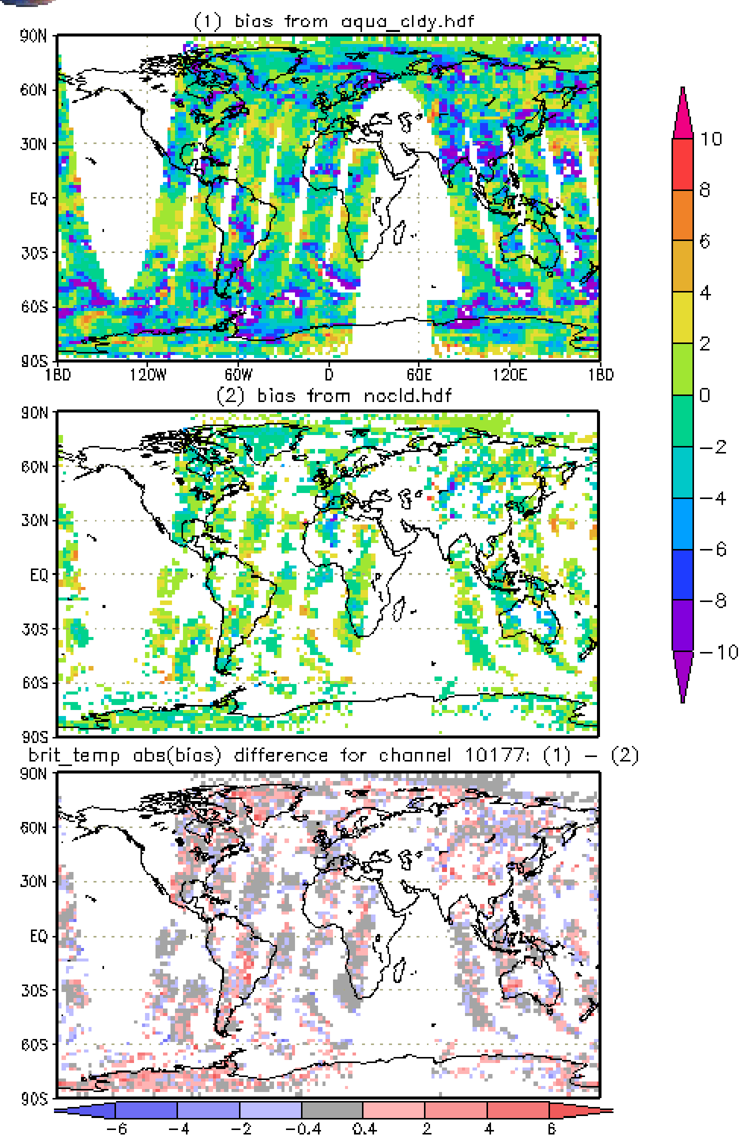


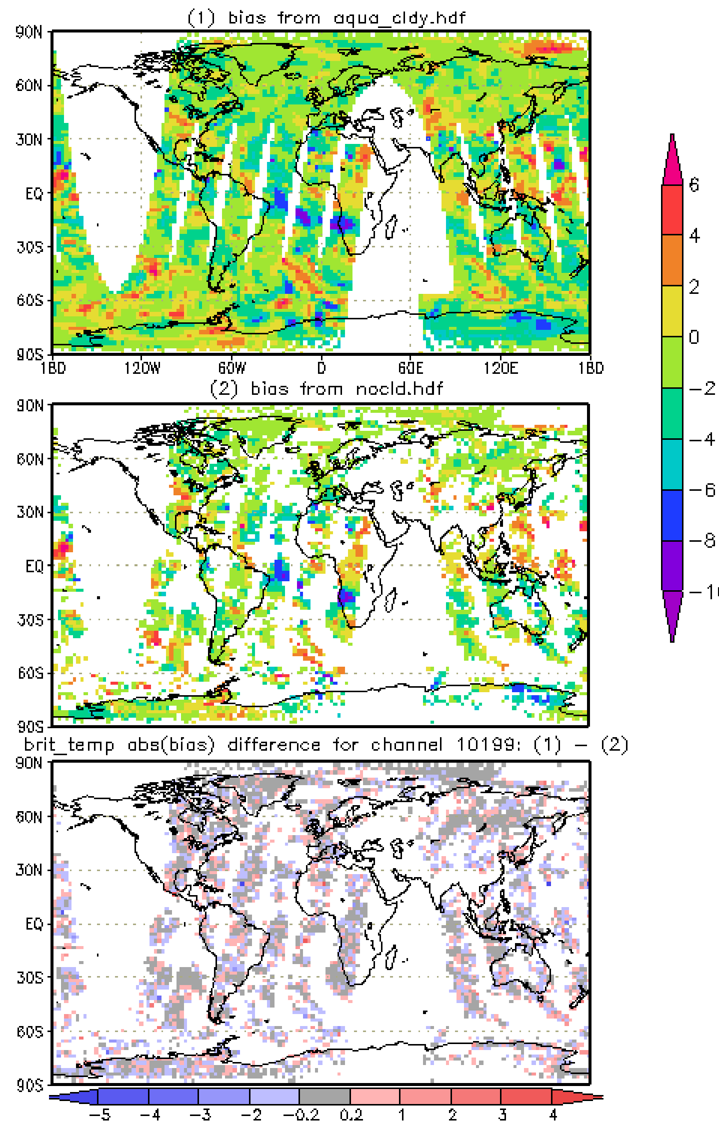
Channels 34, 38 (667.63, 668.64cm $^{-1}$)



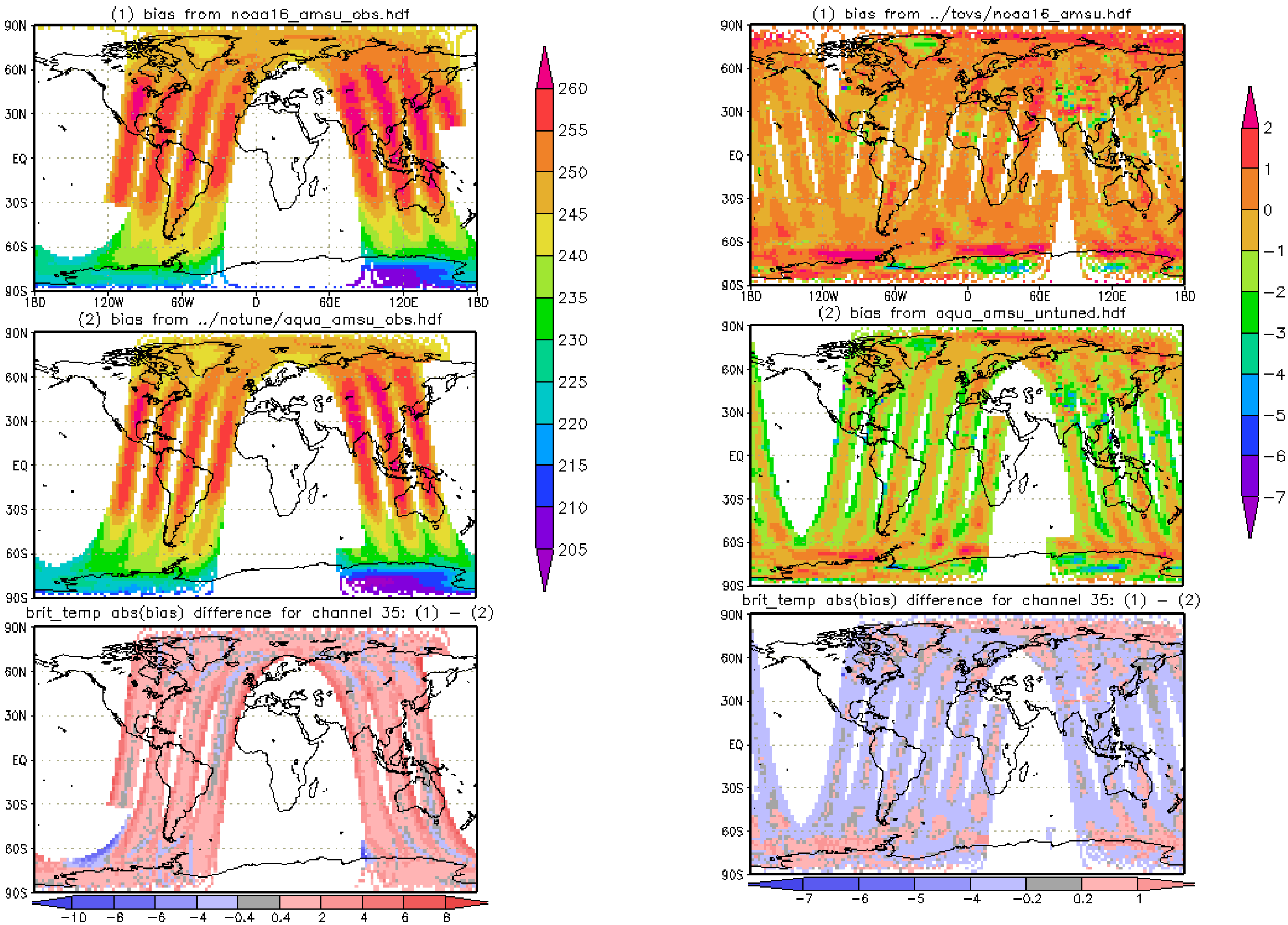


Channels 177, 199 (1356.94, 1520.67 cm $^{-1}$)

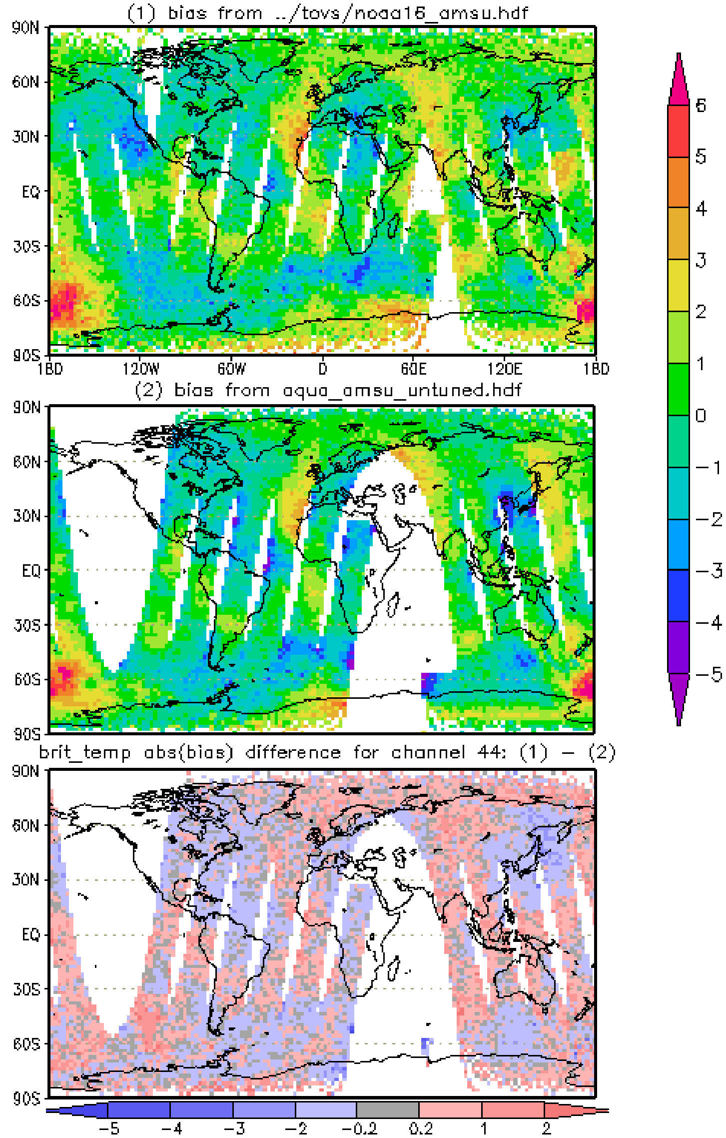


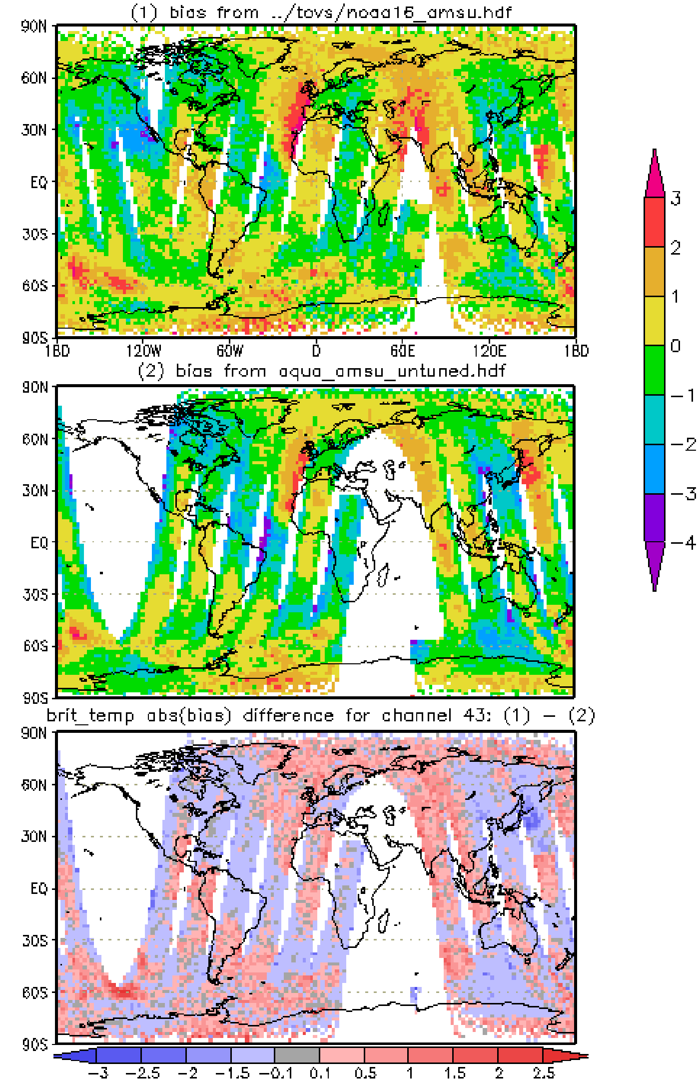


AMSU 5 untuned (NOAA-16 and Aqua)

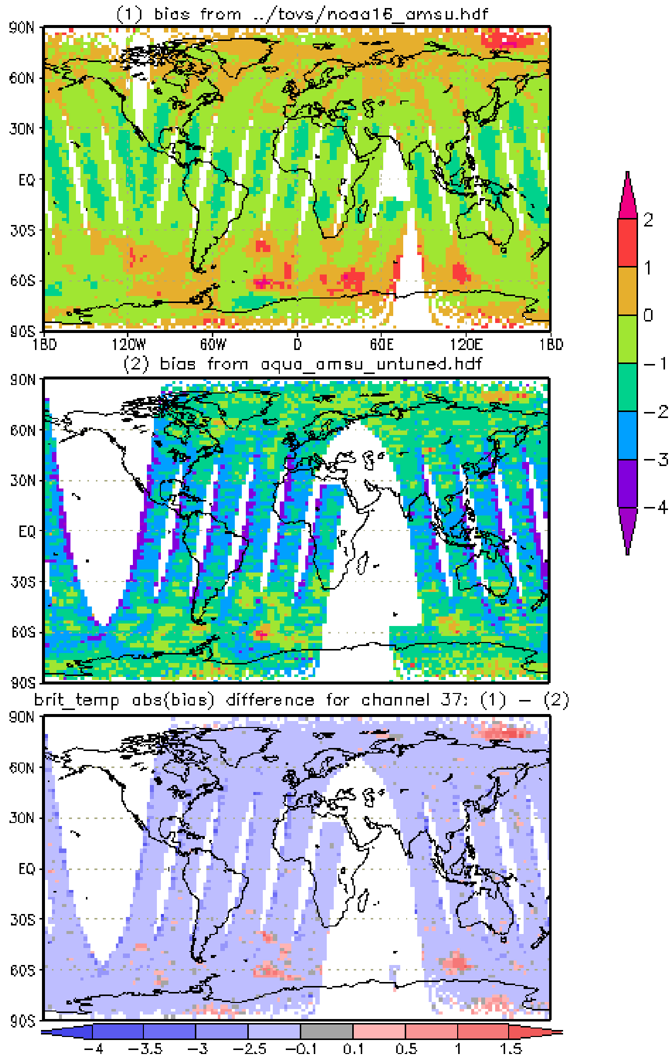


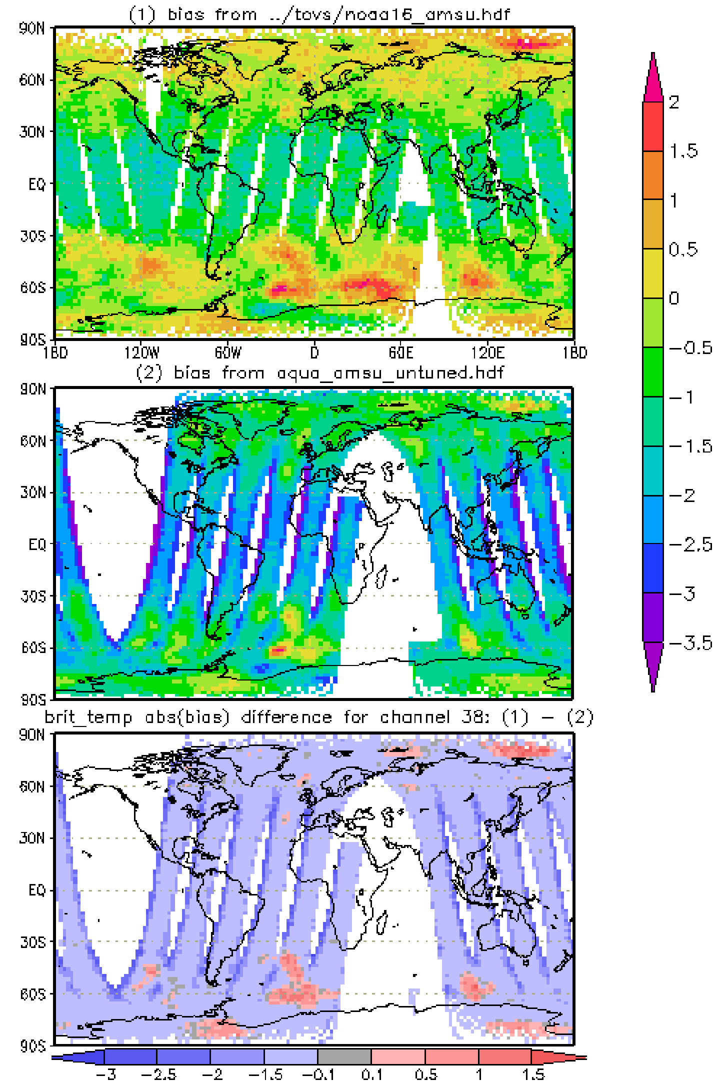
AMSU 14 , 13(Aqua and NOAA 16)



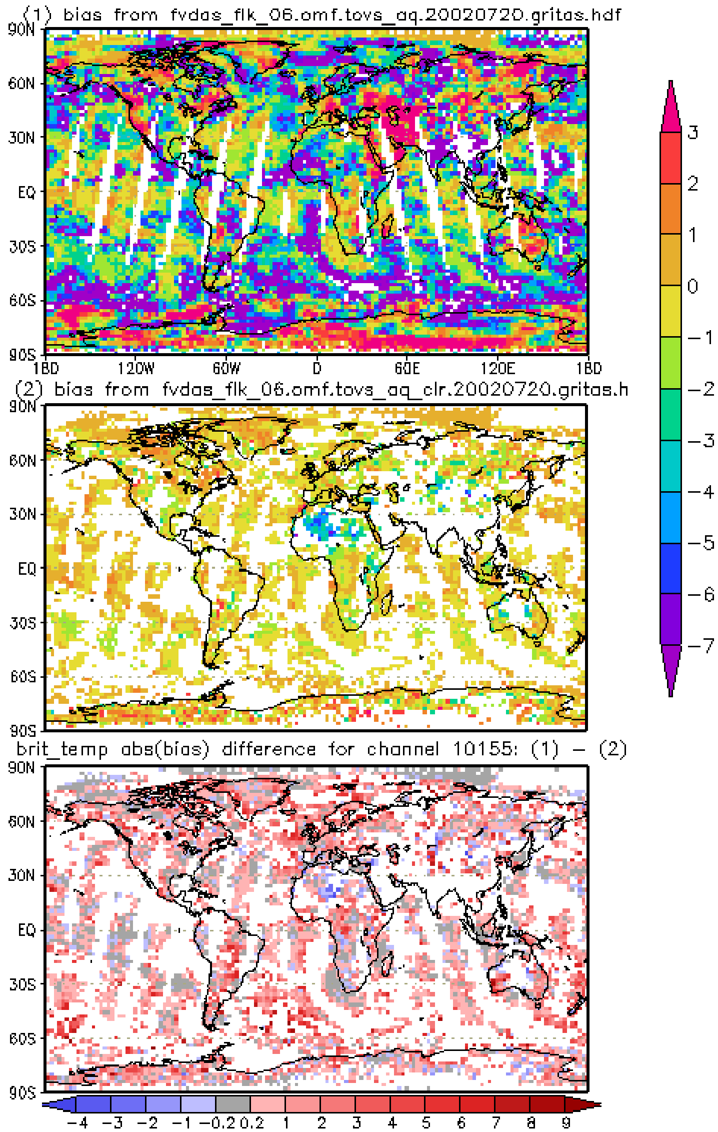


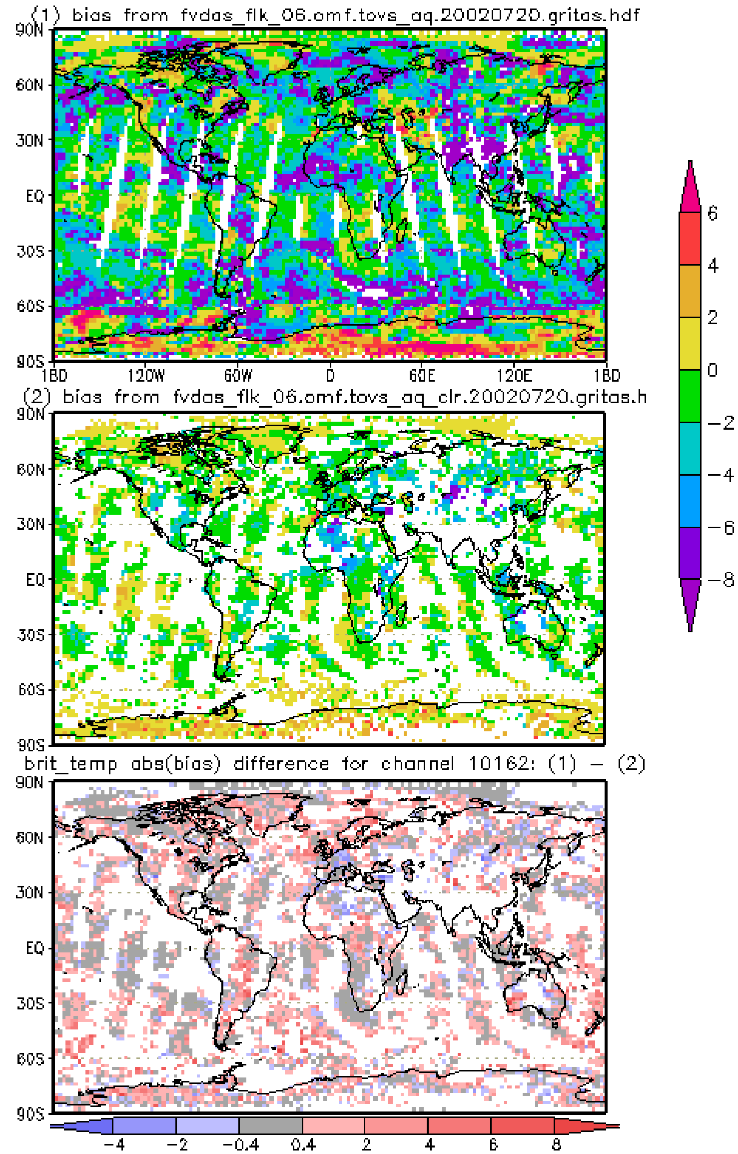
AMSU 7, 8


(1) bias from ../tovs/noaa16_amsu.hdf
(2) bias from aqua_amsu_untuned.hdf
brit_temp abs(bias) difference for channel 37: (1) – (2)


(1) bias from ../tovs/noaa16_amsu.hdf
(2) bias from aqua_amsu_untuned.hdf
brit_temp abs(bias) difference for channel 38: (1) – (2)

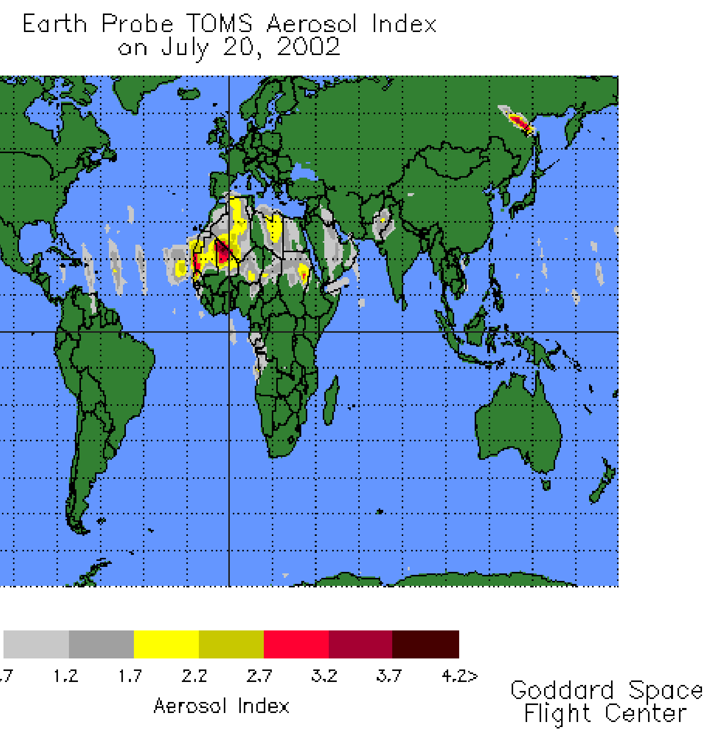
Aerosol and Emissivity Effects





Aerosol Effects

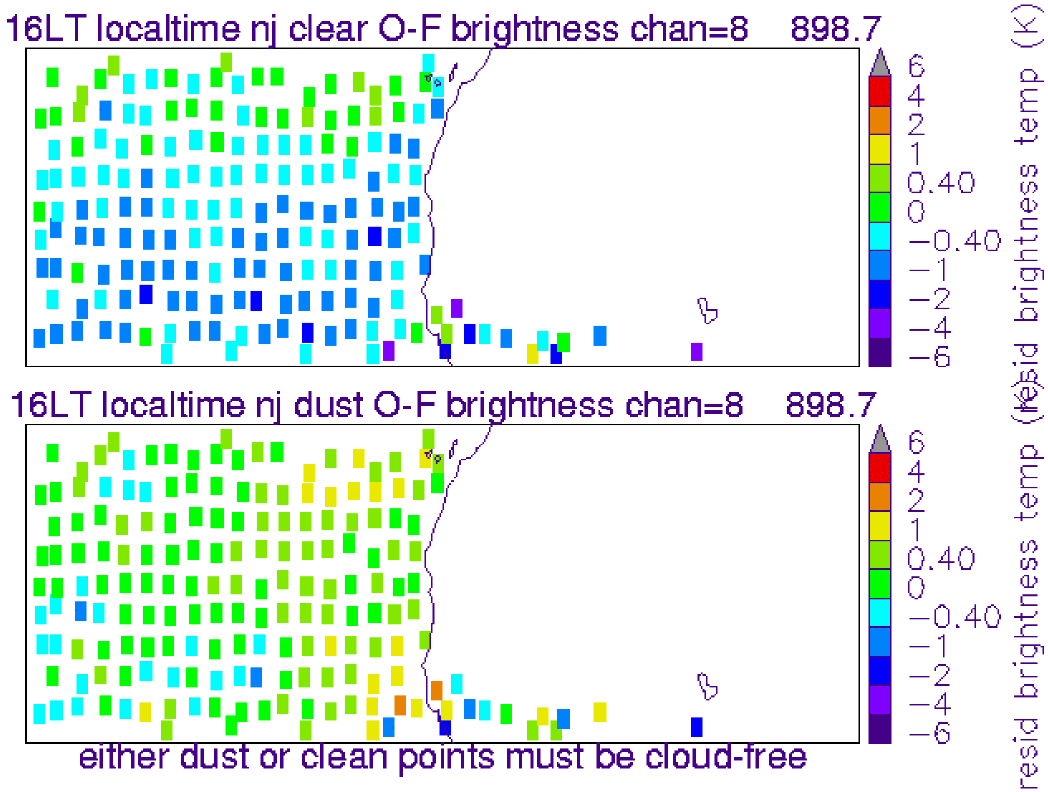
- Weaver, Joiner, and Ginoux have a JGR paper (recently accepted)
  - Added aerosol module to GLATOVS
  - Simulated impact of desert dust type aerosol on TOVS channels
  - Found correlation between O-F radiances over ocean and aerosol column (from GOCART model w/ DAO winds) that was partially correctable
  - Maximum impact around ozone band
  - Will affect all channels that see aerosol-loaded altitudes



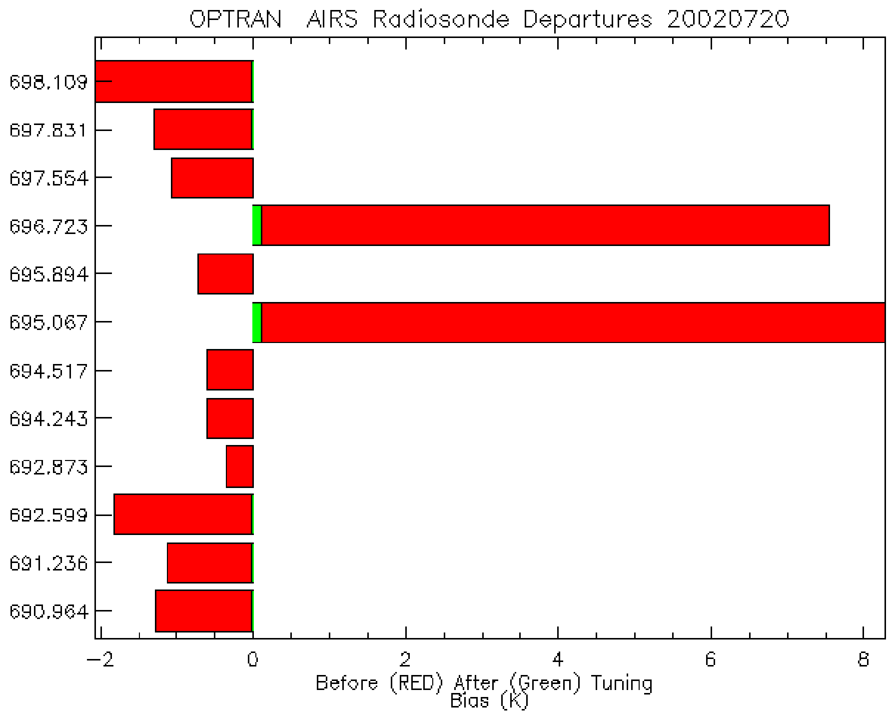
Using model-simulated aerosol

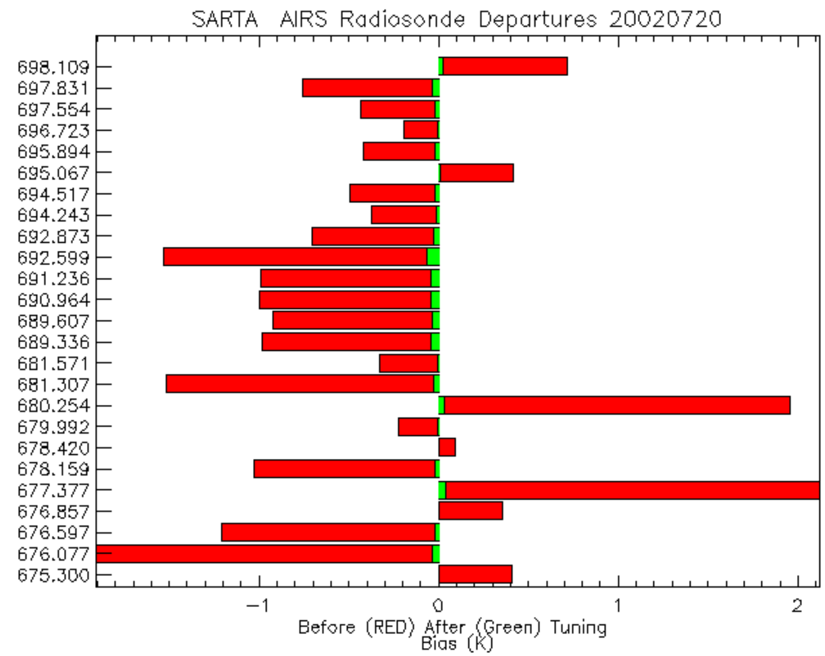
Top: O-F HIRS 8 no dust in calculations

Bottom: O-F HIRS 8 dust from transport model included in radiative transfer

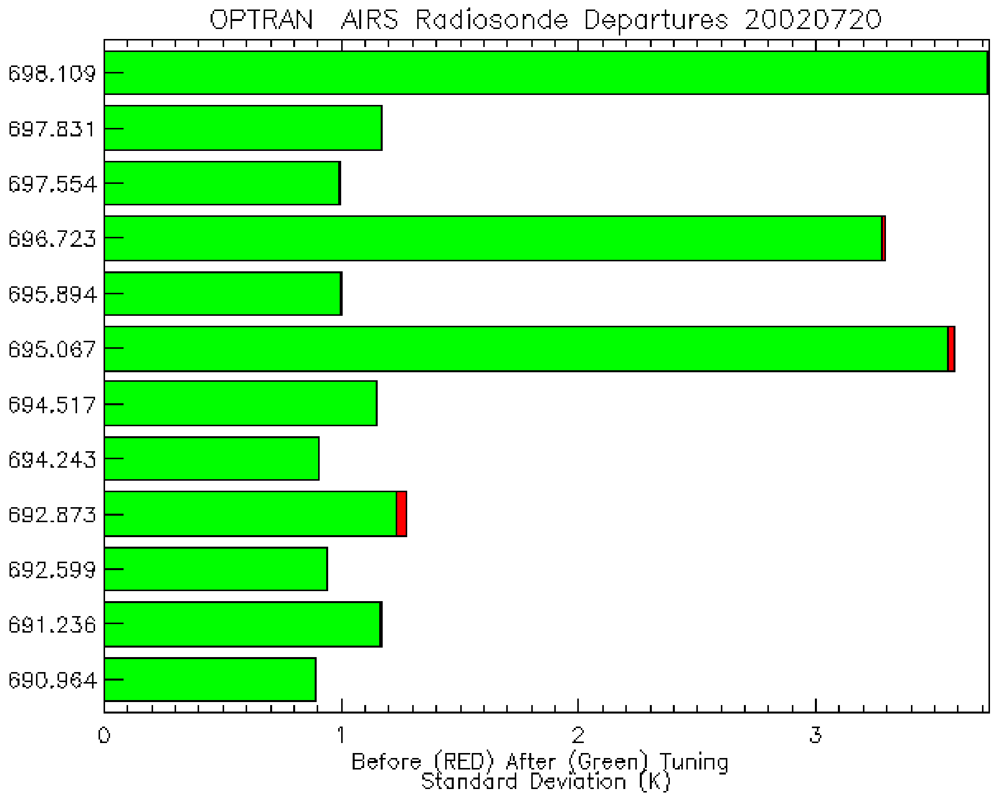


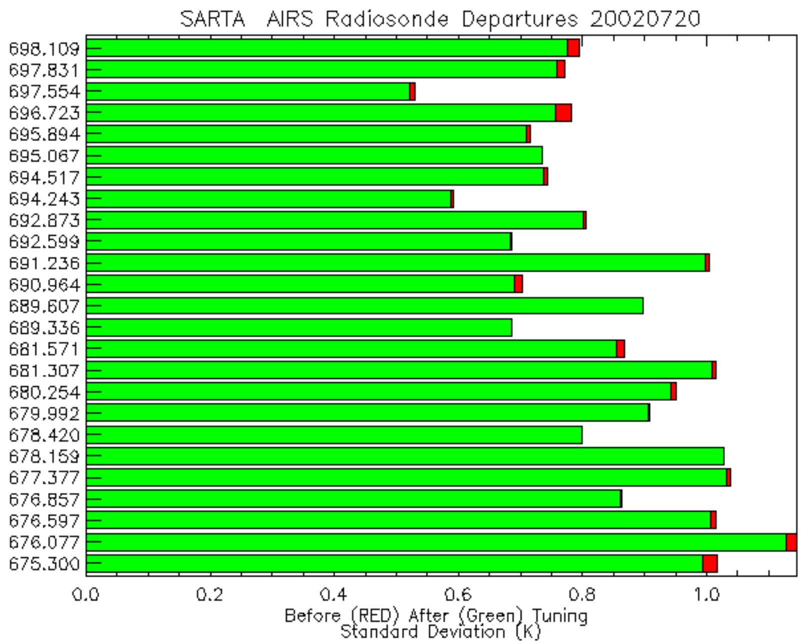
Tuning with radiosondes



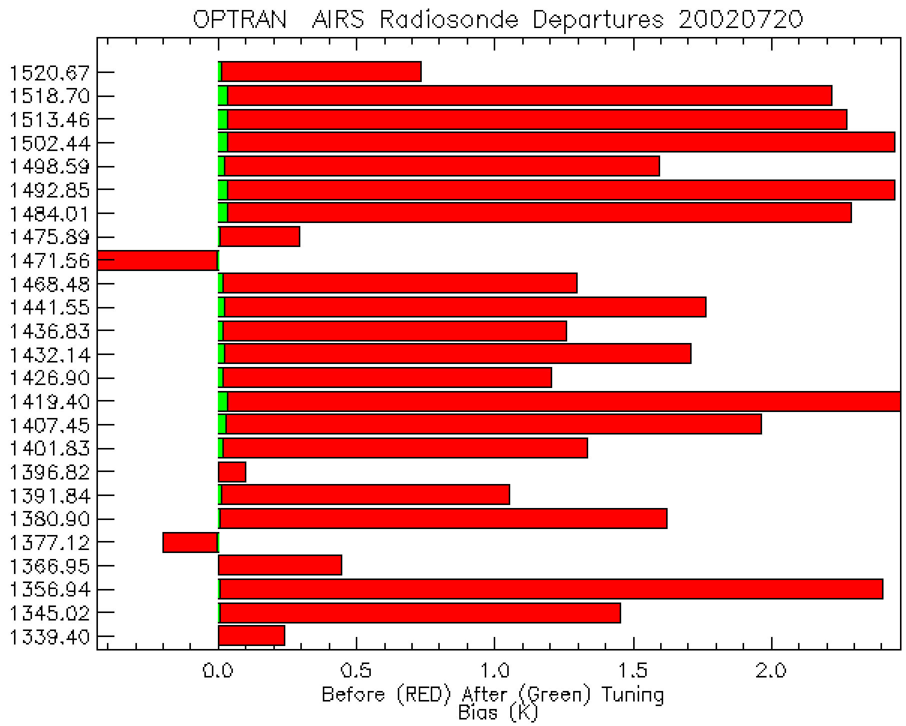


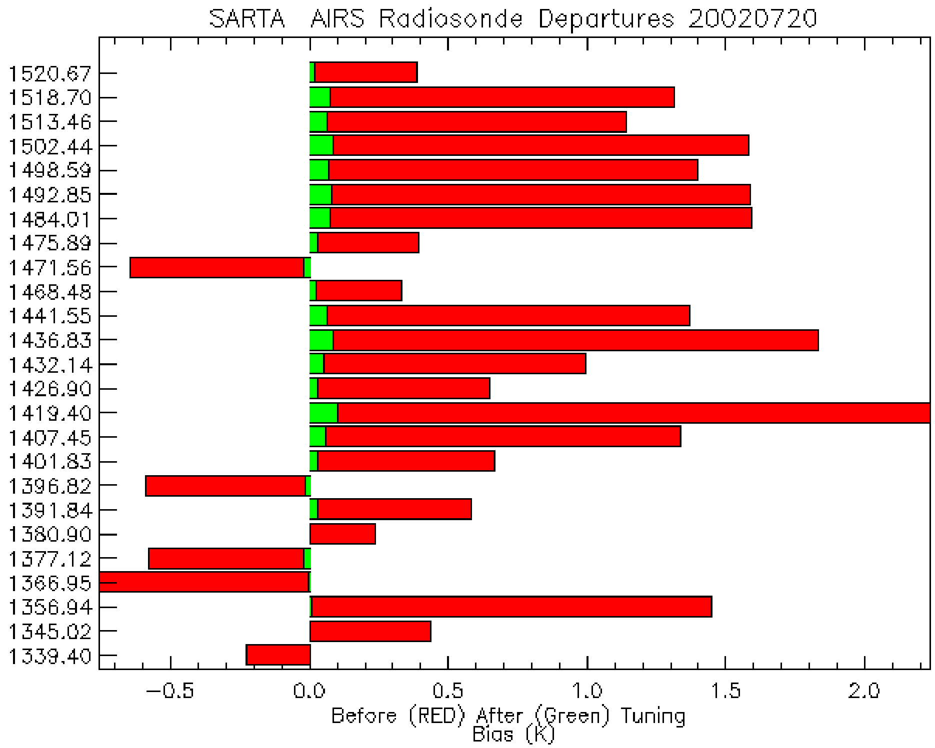
Tuning, long wave



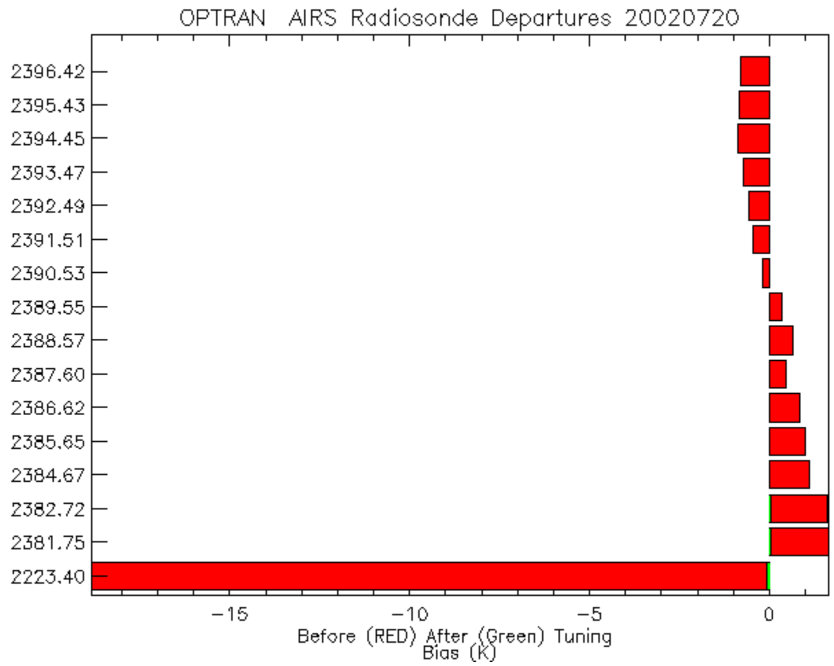


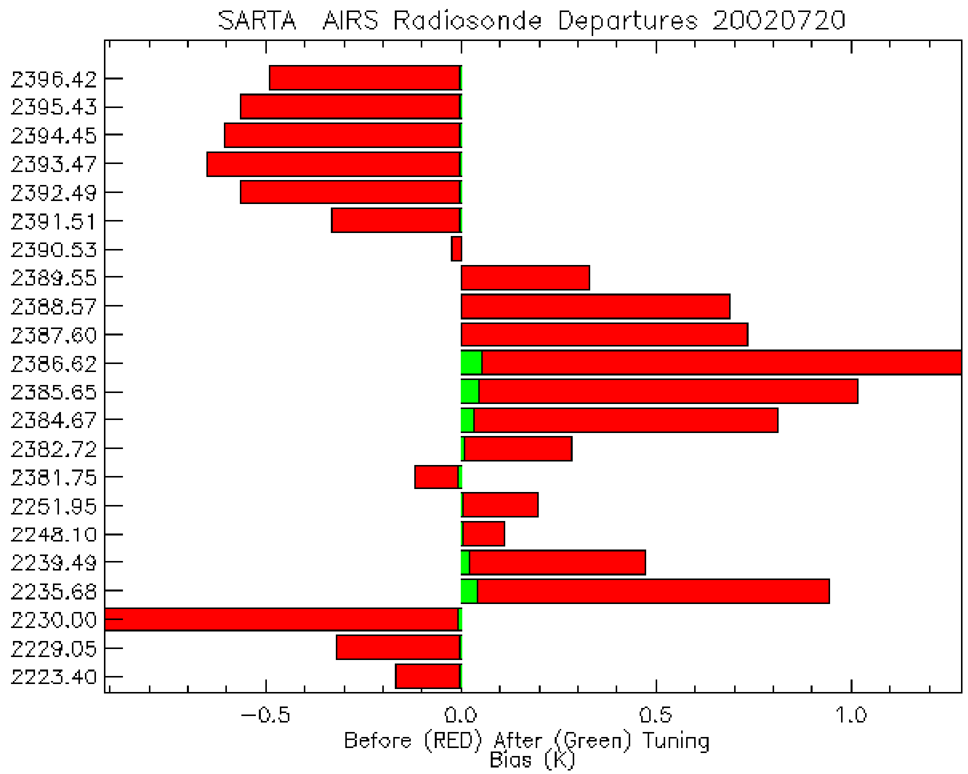
Tuning in water vapor band



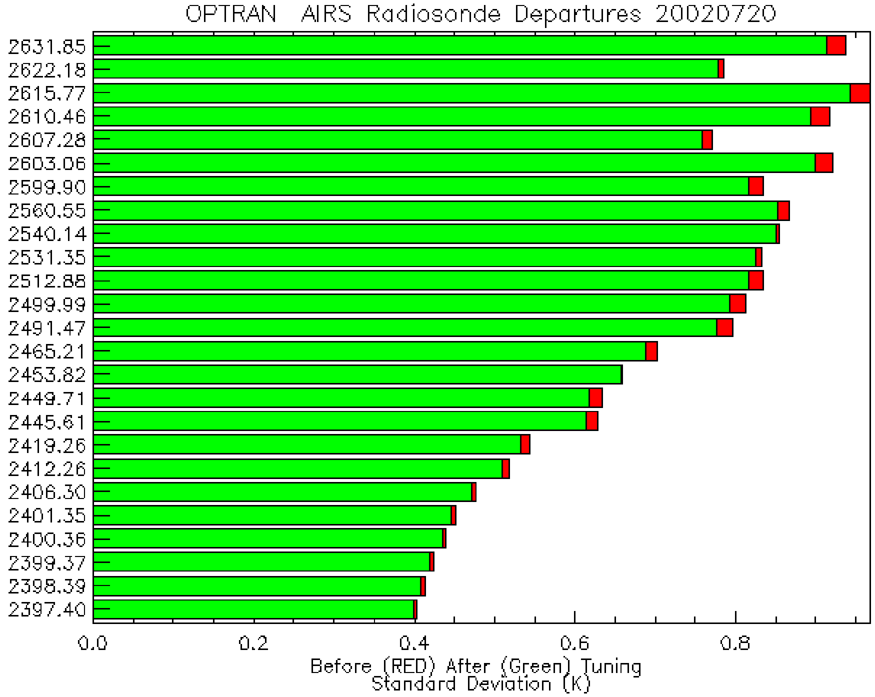


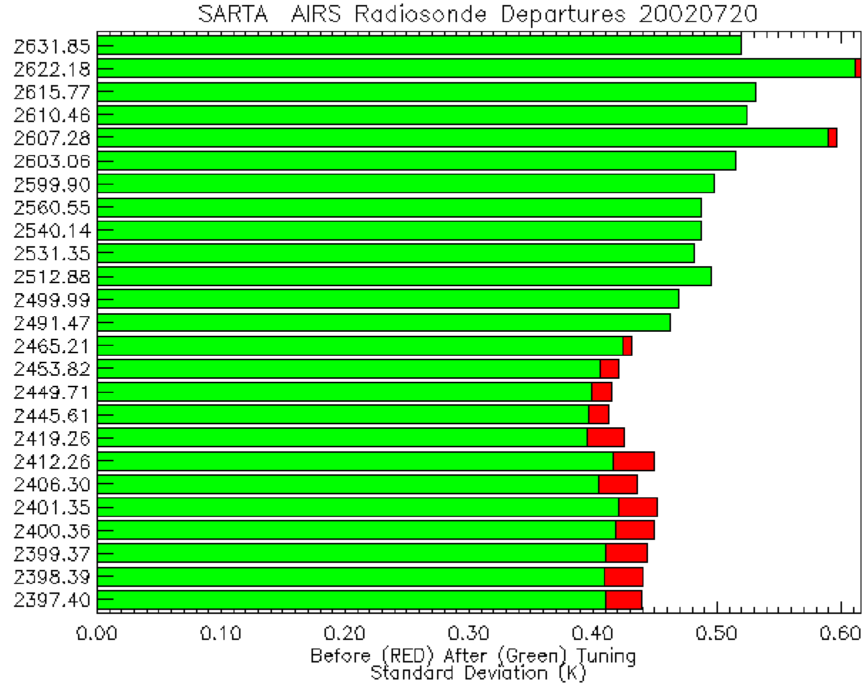
Tuning, short wave



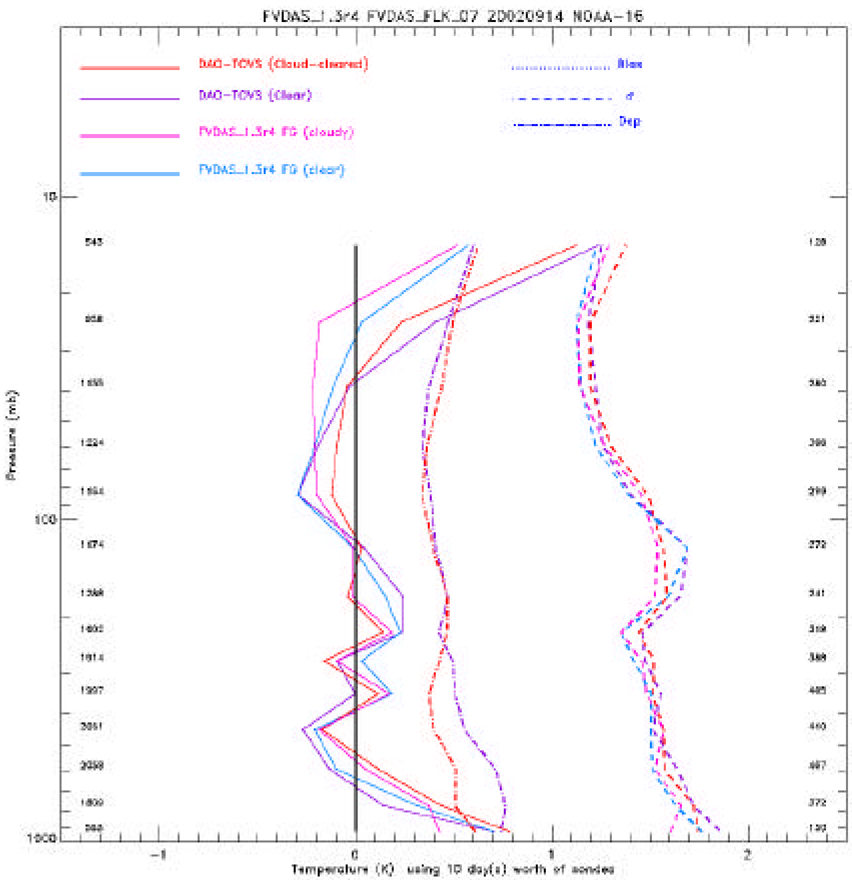


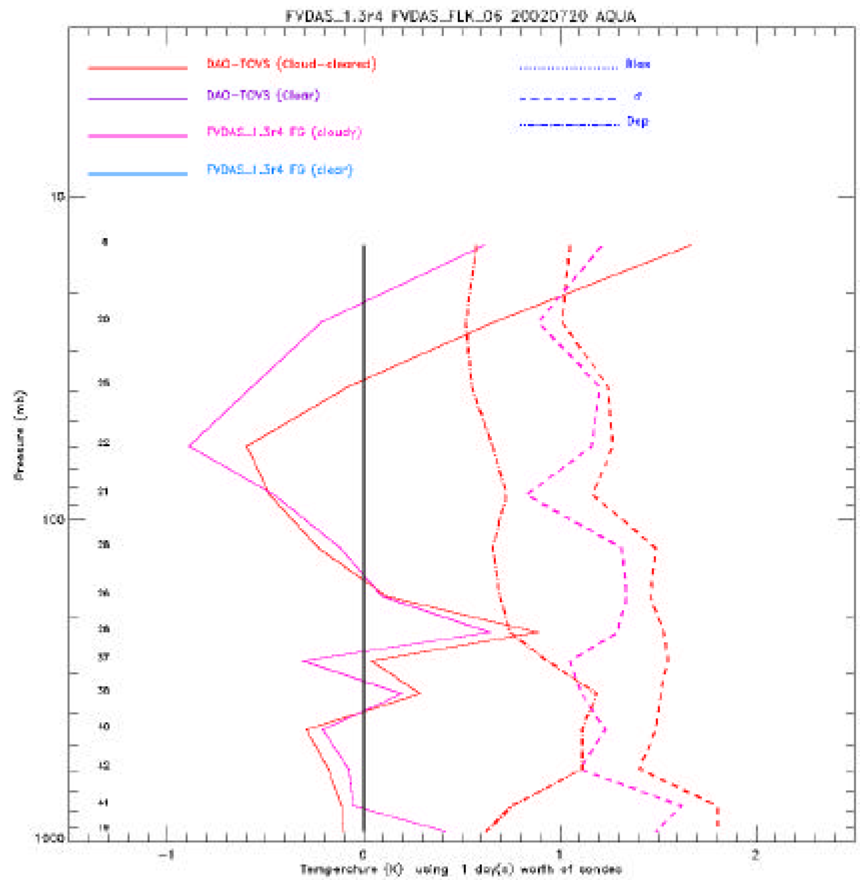
Tuning, short wave





1DVAR runs but not optimized





Timing and other Issues

- SARTA fast Jacobian about twice as fast as OPTRAN Jacobian
- 1DVAR with 178 channels runs in ~12 minutes on 16 CPU's on SGI O2K for 6 hours worth of data (NOAA 16 ATOVS runs in ~3 mins.). Scales with #CPU.
- 1DVAR finds ~11% clear in 1 pixel, ~1% clear in all 9 pixels (similar to NOAA 16)

Conclusions

- Focus-day has been a valuable data set for early diagnostics and testing
  - O-F radiance provide useful tool for determining channels affected by non-LTE, aerosol
  - O-Fs also show model problems such as mesospheric temperature bias over Antarctica
  - Has enabled us to tune 1DVAR
- DAO is ready for more data and updated RT
  - need several months of data for definitive impact studies
- Would like to have updated estimates of radiance errors (NEDT, forward model errors)
- Would very much like to have sidelobe-corrected AMSU